LABORATOIRE DES SCIENCES DU NUMÉRIQUE DE NANTES

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Environmental vulnerability of the global ocean plankton community interactome

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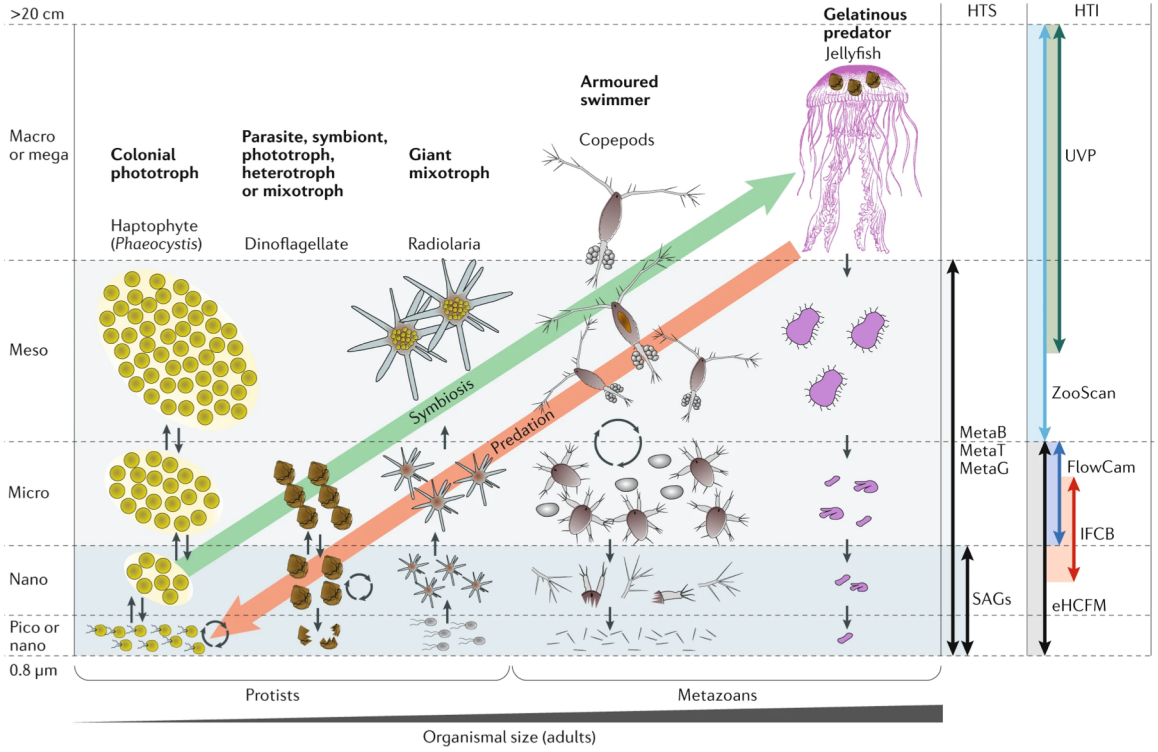
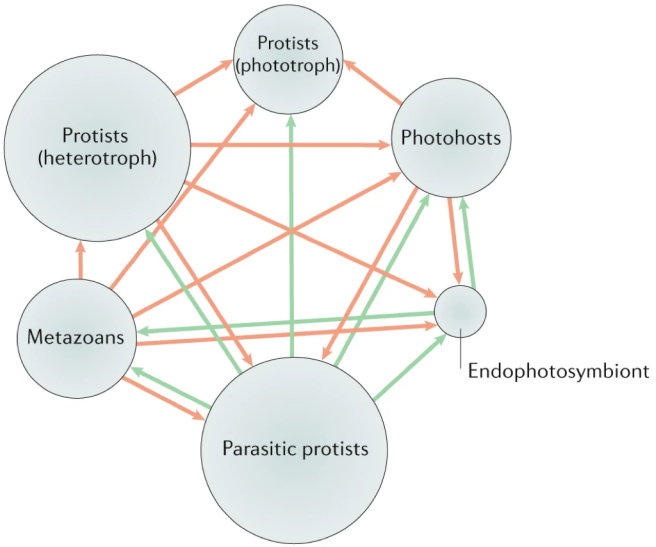
Plankton Systems Ecology

- Plankton activities and interactions balance Earth's ecosystems
- Biotic interactions can influence species distributions and (metabolic) evolution

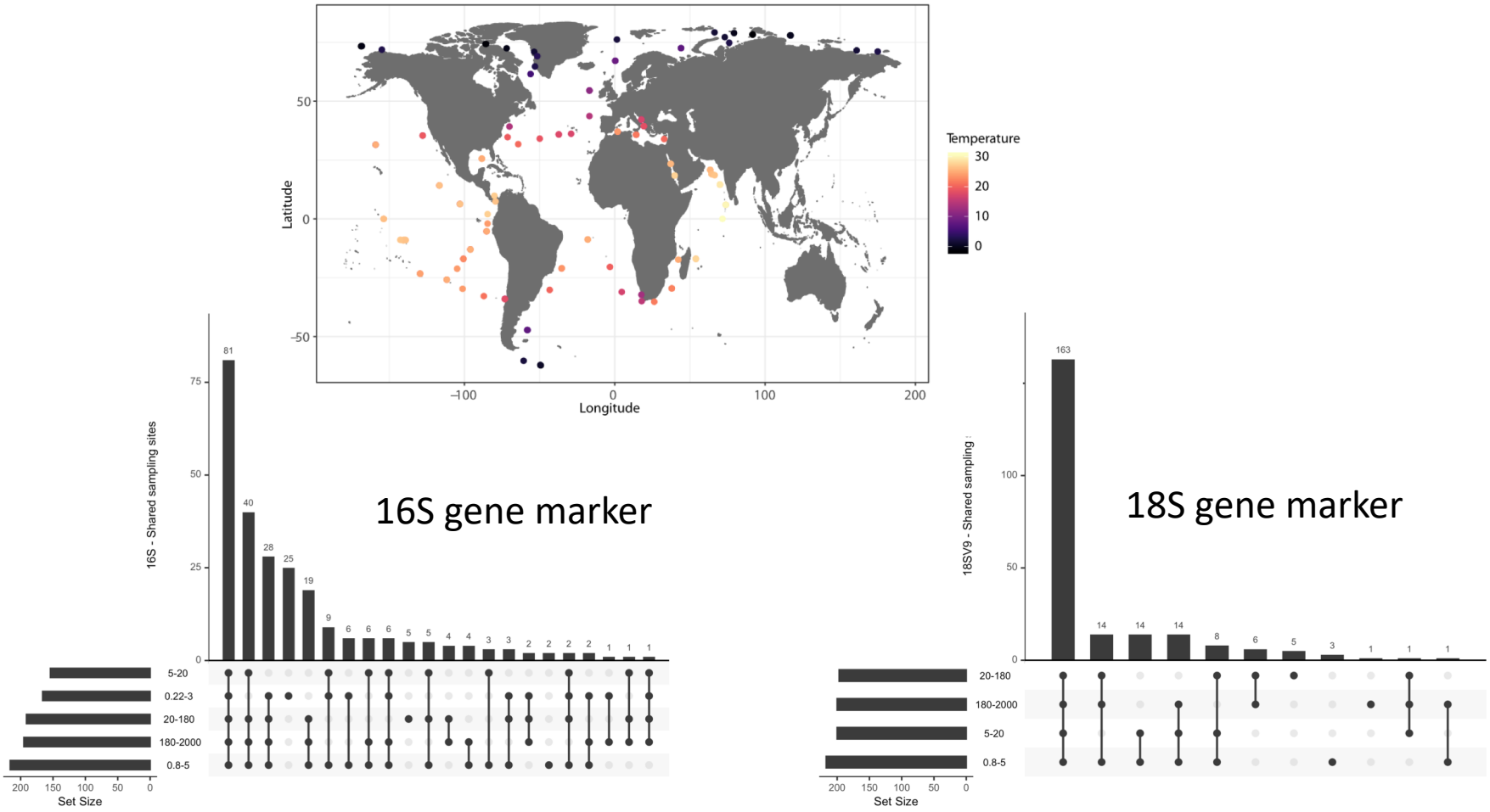
Main questions:

- **Who interacts with who, and where ?**
- **How plankton interactions will be affected by anthropogenic climate change ?**
- What are the mechanisms of plankton interactions ?
- How species interactions are shaping plankton ecology and evolution ?



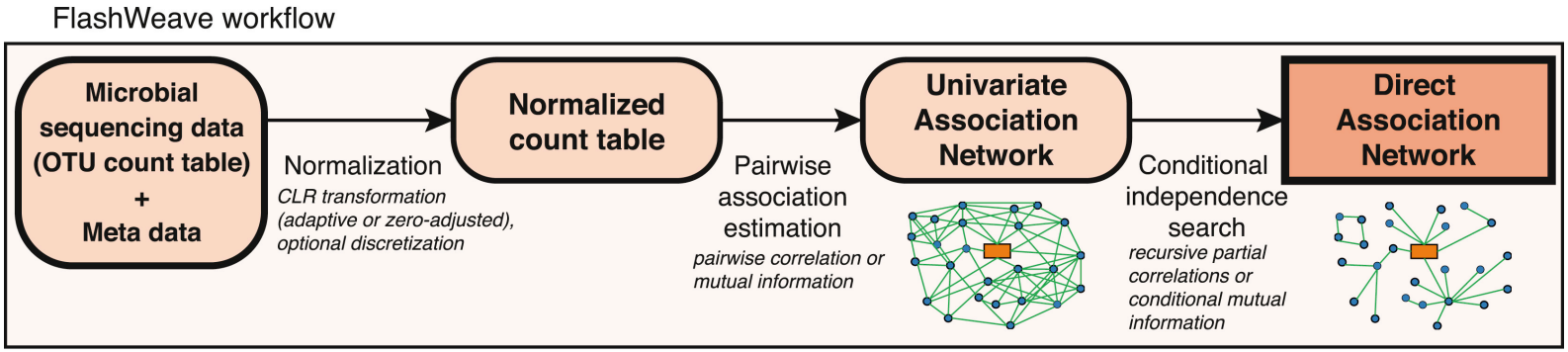


Leveraging *Tara* Oceans global sampling



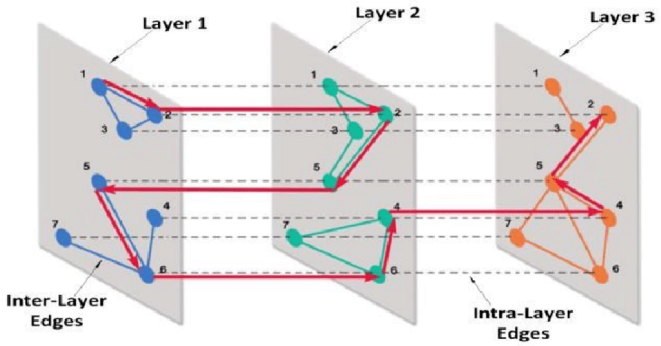
- Cross-domains (Prok. & Euk.) metabarcoding data (16S & 18S) across size fractions
- Global-scale sampling along the latitudinal axis (extensive temperature gradient)

Inferring “direct” plankton associations



Tackmann et al. Cell Systems.

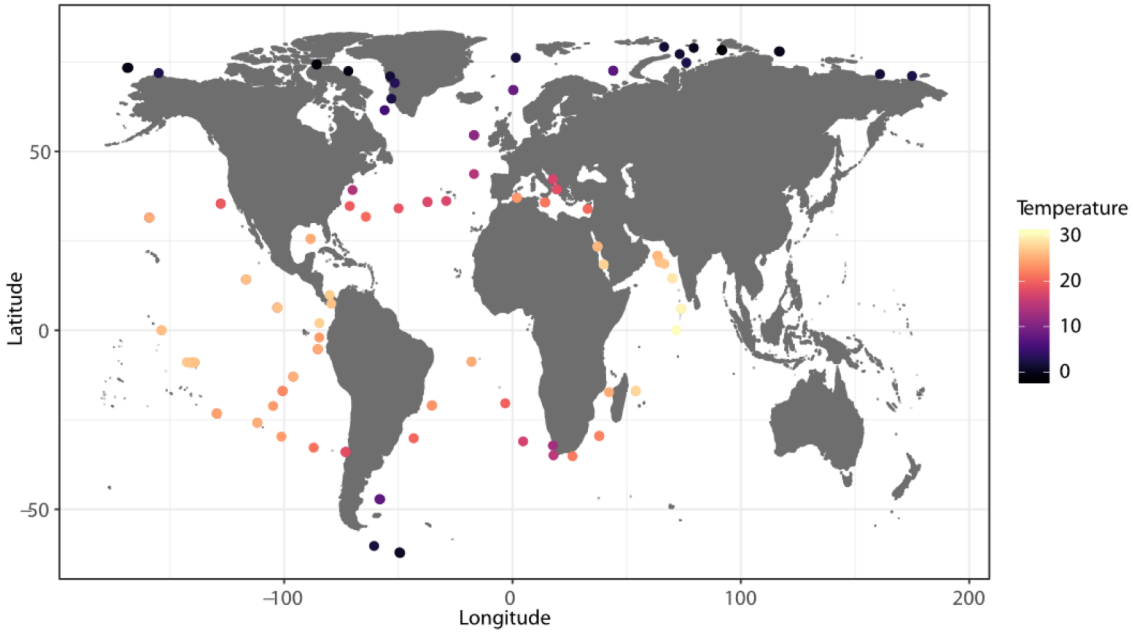
1. Graph inference within each layer (i.e. one gene marker in one size fraction) → Union graph **G**
2. Graph inference across 2-layers → Add edges to **G**
3. Graph inference across 3-layers and filtering of “unstable” edges (occurrence < 50 %) → Filter **G**

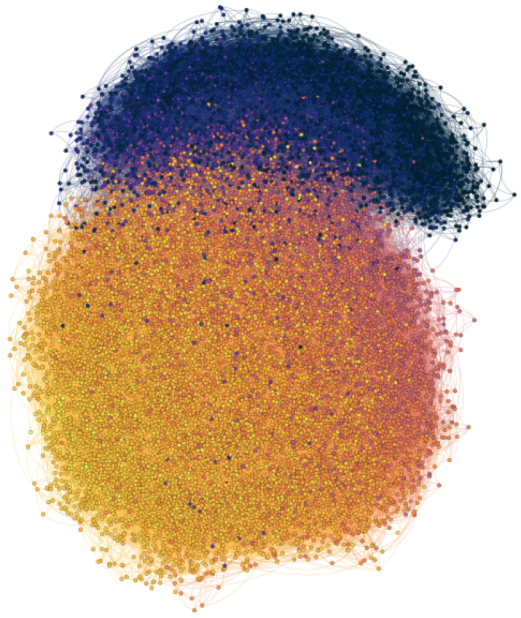


Chaffron et al. under review.

- Detection of indirect associations via conditional and iterative independence search
- Removal of indirect (purely correlational) associations reported by univariate methods
- Graph **G** of predicted direct plankton interactions within and across size fractions

The global ocean plankton *interactome (v2)*

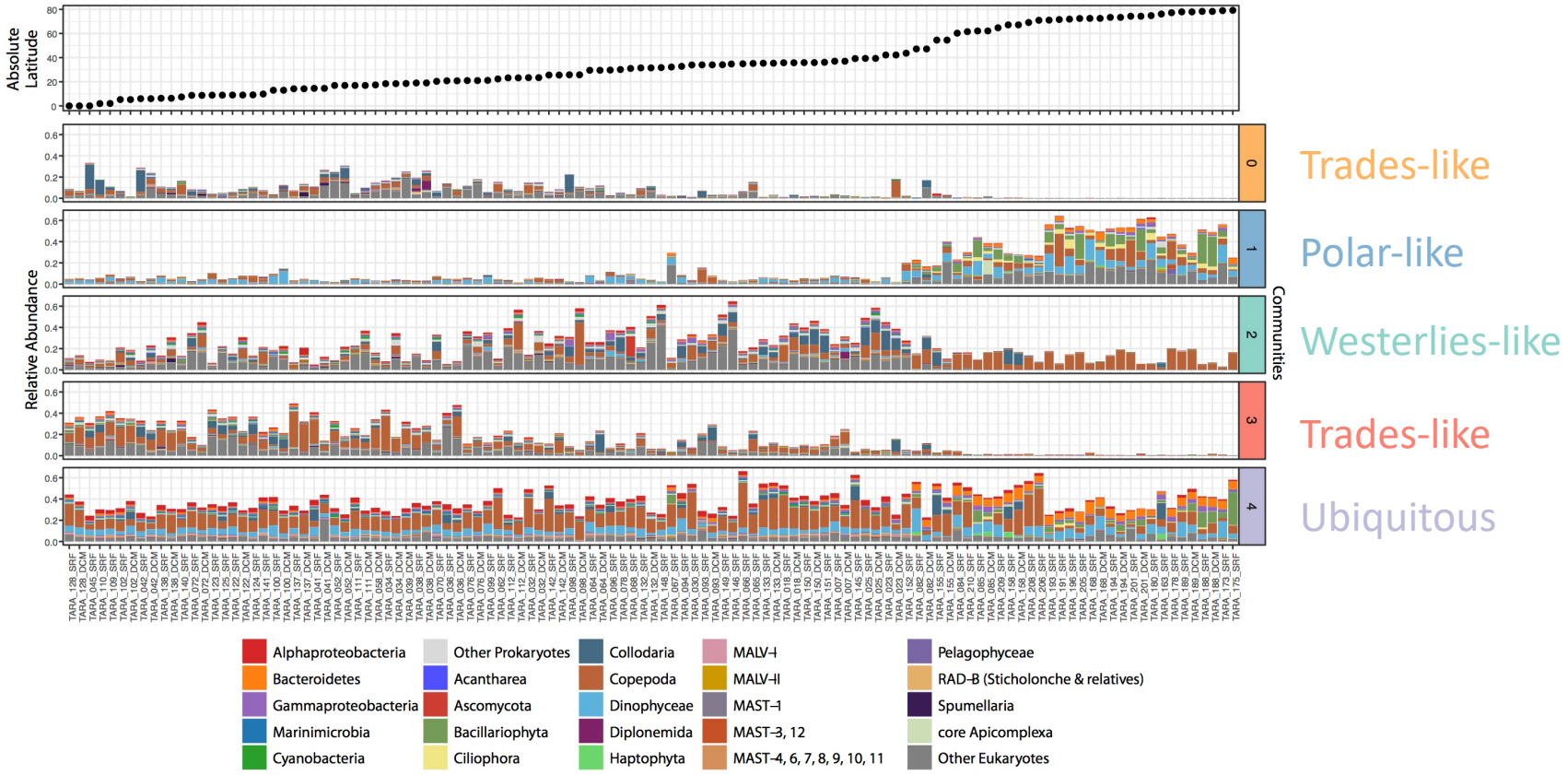




- Novel plankton *interactome* now including Arctic samples
- Cross-domains (Prok. & Euk.) predicted plankton interactions from pole-to-pole
- Strong latitudinal structuration of predicted interactions (temperature gradient)

Chaffron et al. under review.

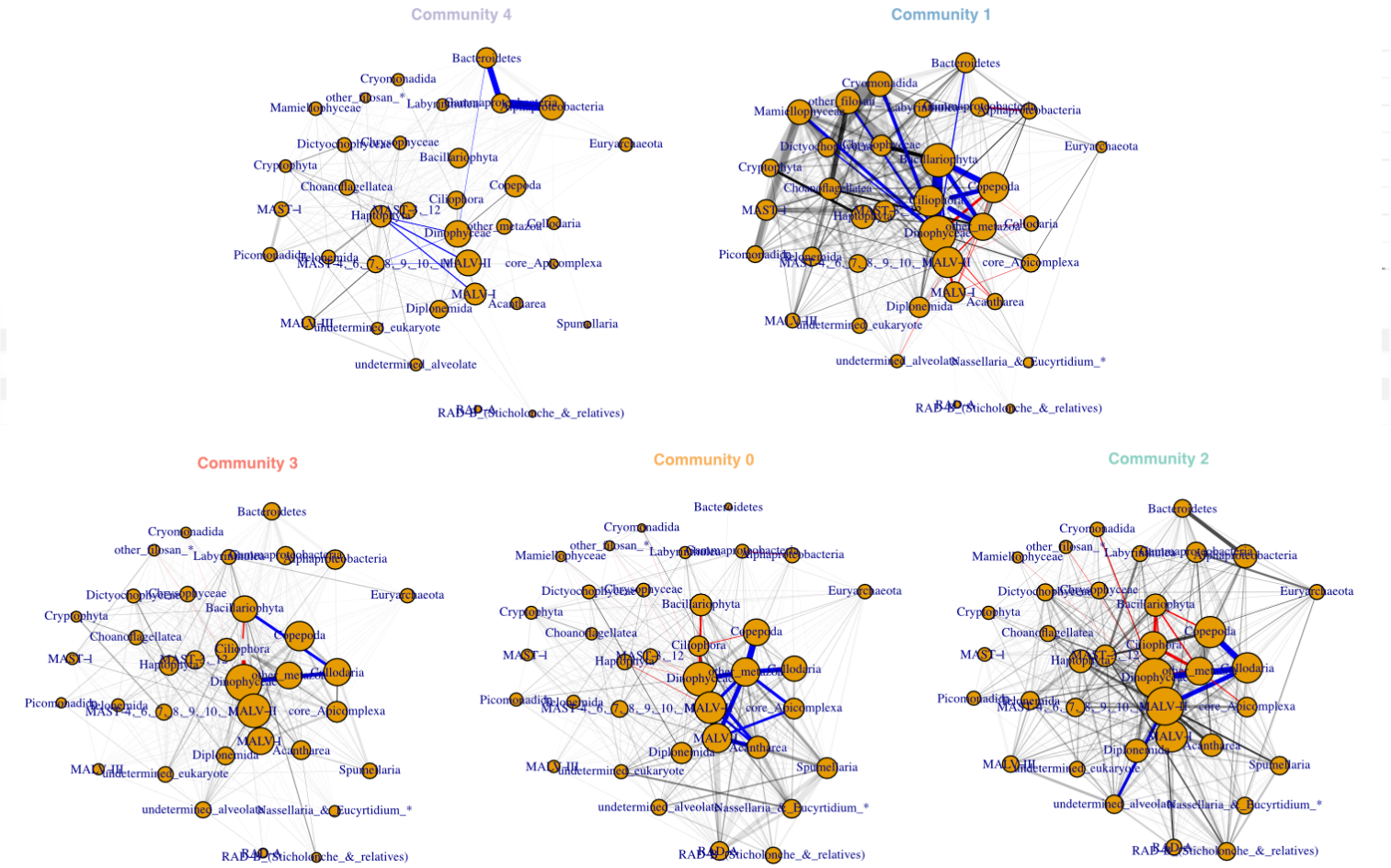
Biome-specific communities emerge from the plankton interactome



- Eigenvector-based spectral clustering algorithm for community detection
- Four biome-specific communities emerge from the interactome
- One ubiquitous community spans the entire latitudinal gradient

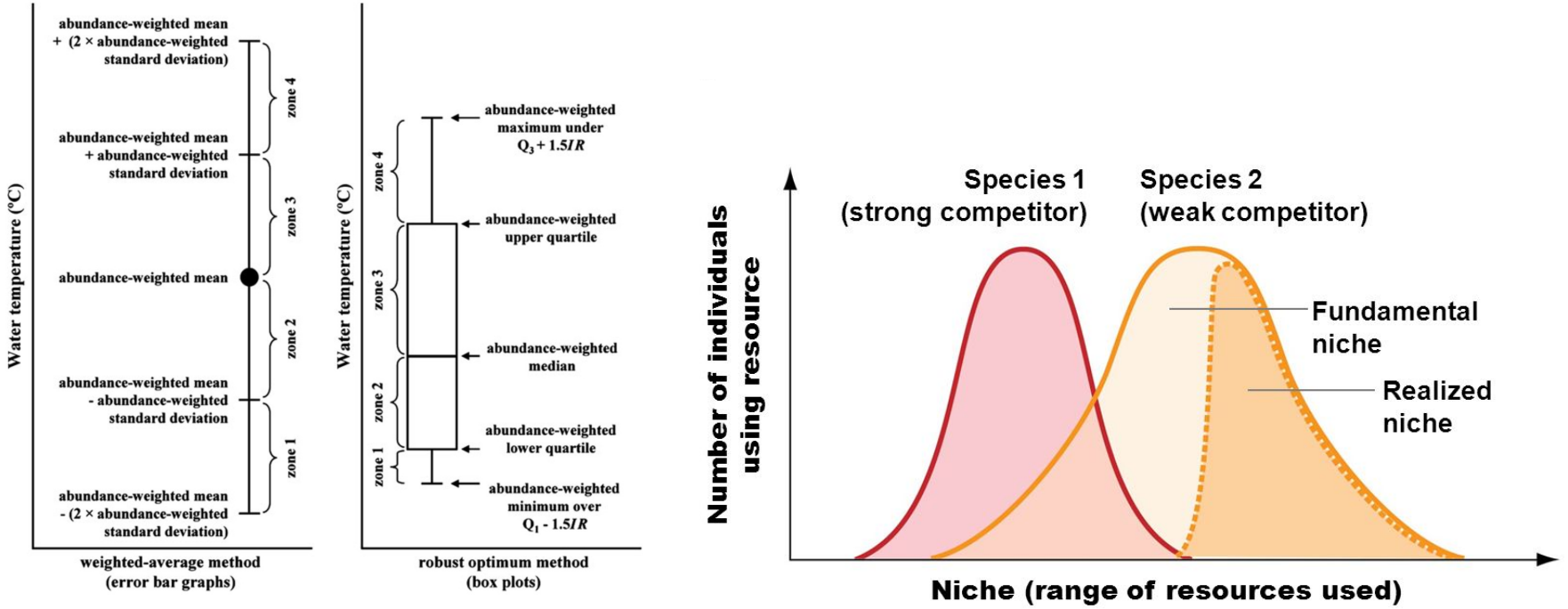
Chaffron et al. under review.

Biome-specific communities emerge from the plankton interactome



- These communities display very distinct (local) interactomes
- Specific associations are enriched in each community

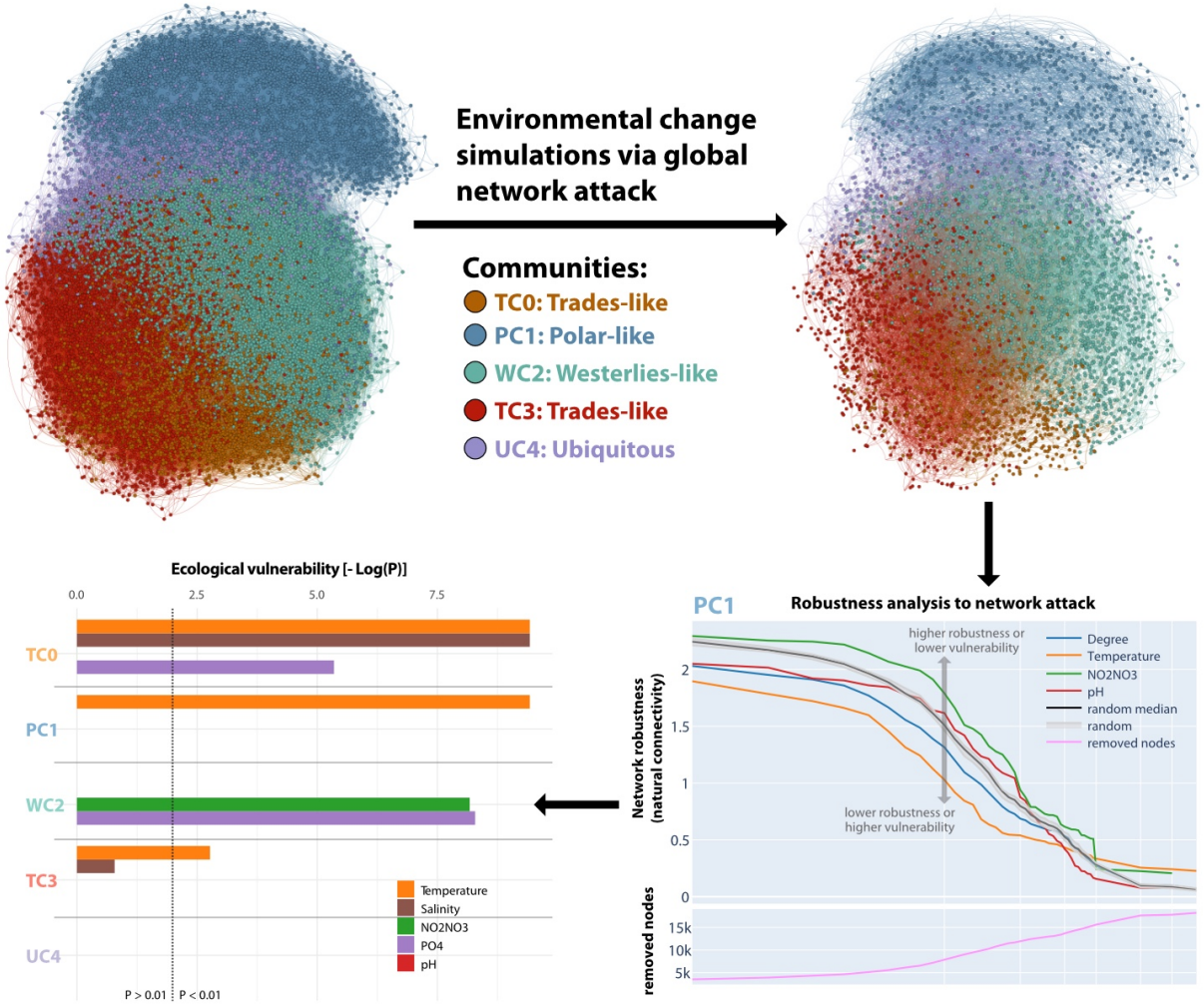
Realized niche width inference



Cristóbal et al. 2014

- Pole-to-pole sampling enables ecological optima and realized niche width (i.e. estimated tolerance range) inference

Distinct vulnerabilities of plankton communities to environmental change

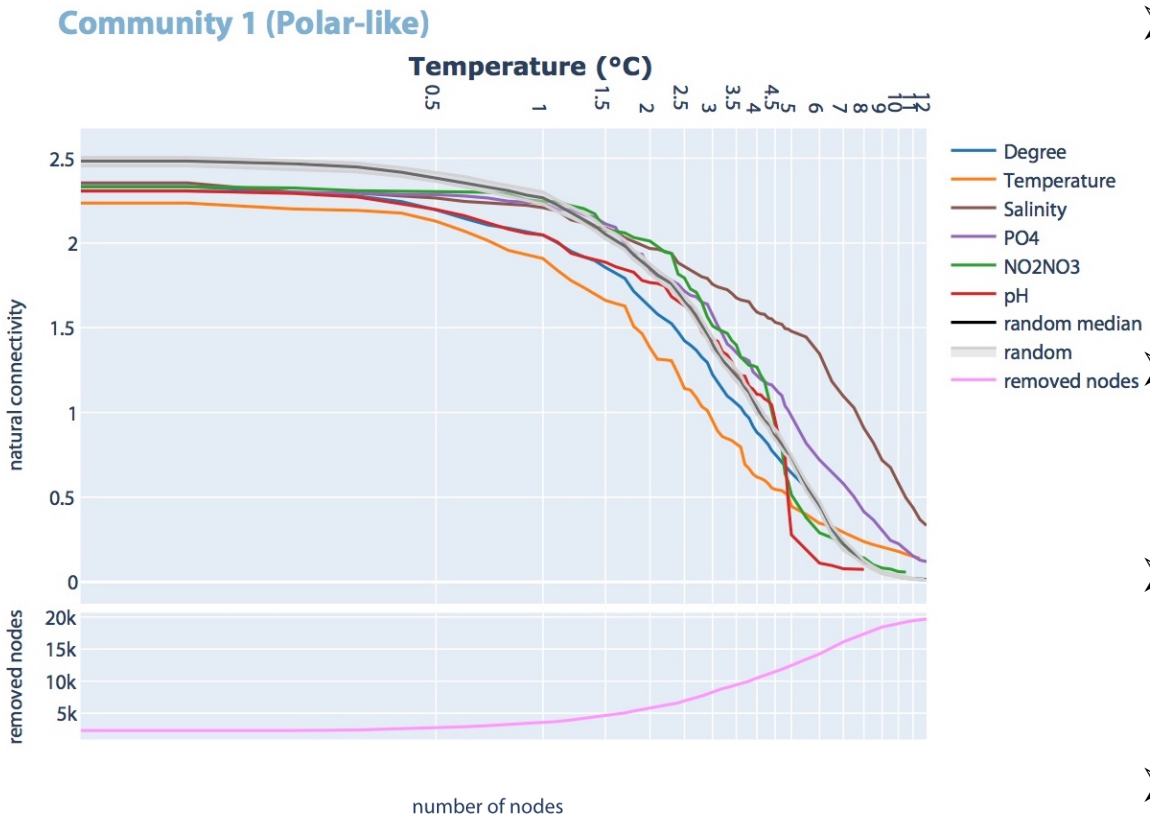


Network robustness analysis:

- **Natural connectivity:** redundancy of alternative paths in a network based on evaluating the weighted number of closed walks.
- **Randic's index:** A degree-based topological index measuring the process of connecting various parts of a network.

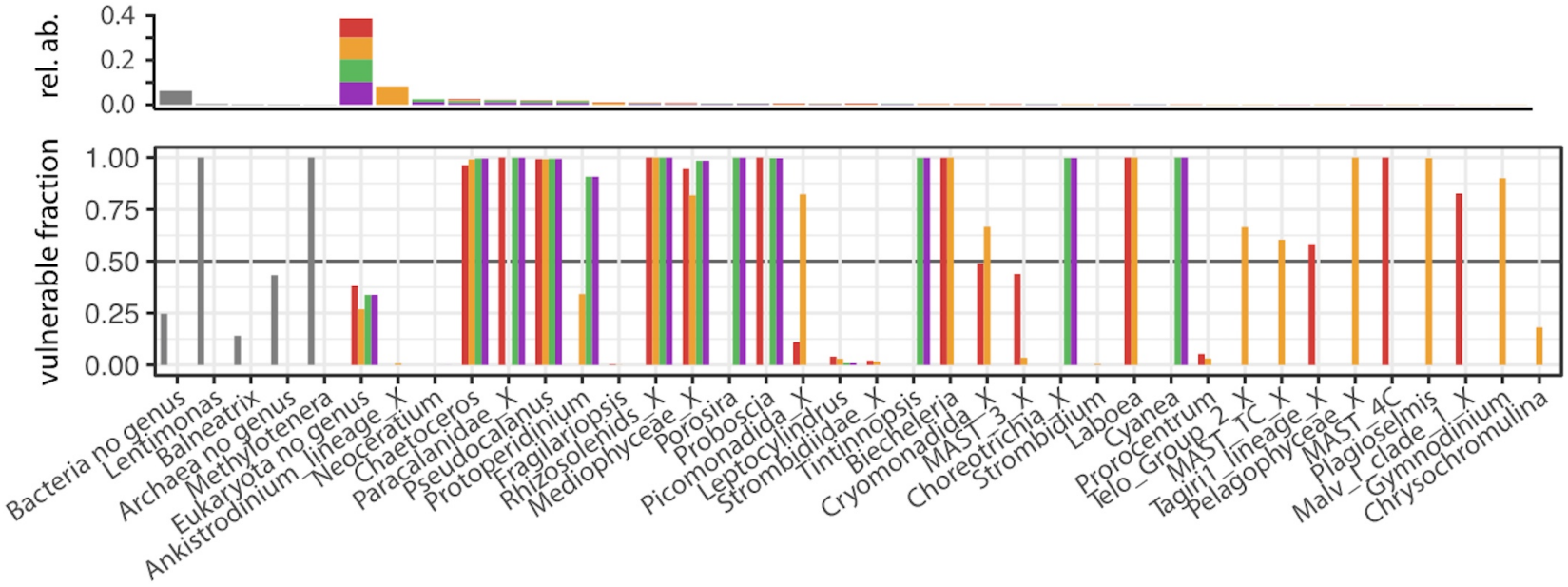
Chaffron et al. under review.

Community-specific vulnerabilities of the *interactome*



- Graph-based perturbations reveal *interactome* **global robustness**
- **Trades vulnerability** to temperature and salinity
- **Westerlies vulnerability** to nutrients conc. changes
- **Polar vulnerability** to temperature changes

Polar lineages potentially most impacted by temperature change



- *Lentimonas* and *Methylotenera*, and several uncharacterized OTUs
- Several abundant diatom genera: *Chaetoceros*, *Porosira* and *Proboscia*
- Copepods genera: *Pseudocalanus* and genera from the family Paracalanidae

➢ **Potential species indicators of polar ecosystem change in response to ocean warming**

Chaffron et al. under review.

Take-home messages

- A **cross-domains** of life plankton interactome from **pole to pole**
- Higher interactome connectivity and **“stability” at the poles**
- Temperature, salinity and nutrient concentrations shape the plankton interactome structure
- **Biome-specific communities and ecological associations** emerge from the plankton interactome
- Global robustness but **local biome-specific vulnerabilities** of the interactome to environmental changes

Acknowledgements

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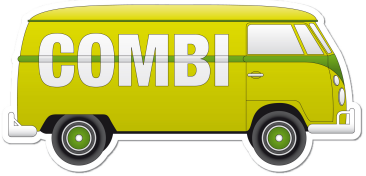

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